



Environmental Effects of Dredging Technical Notes



Long-Term Evaluation of Times Beach Confined Disposal Facility, Buffalo, New York; An Update

Purpose

This technical note summarizes the results of an evaluation of the fish community at the Times Beach Confined Disposal Facility and is applicable to all Corps of Engineers Districts that evaluate the long-term effects of dredged material placed in confined disposal facilities (CDFs).

Background

After the open-water disposal of dredged sediments was observed to have deleterious effects on the aquatic ecosystems of the Great Lakes, an alternative was sought to reduce the exposure of lake biota to dredged material contaminants. In 1970, the Rivers and Harbors Flood Control Act authorized the U.S. Army Corps of Engineers to construct CDFs to contain material dredged from contaminated Great Lakes harbors and waterways. These CDFs may be located in open water, alongshore, or inland from a dredging operation. Most of those CDFs located in open waters are constructed of stone-walled dikes with synthetic or steel sheeting to prevent leaching of contaminants through the dike. The dredged material enters as a slurry through a discharge pipe from the dredging operation. Suspended solids (including contaminants) settle before the effluent drains through a weir system at the outlet of the CDF opposite from the discharge pipe. The size of Great Lakes CDFs ranges from a few to hundreds of hectares. Once filled, the land created by the dredged material potentially can be used for recreational areas, agricultural or industrial development sites, or as wildlife refuges. CDFs can be invaded by aquatic organisms via water-level fluctuations, storm events, or unauthorized stocking. A total of 38 CDFs have been established in the Great Lakes region.

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This technical note describes a study representing the first concerted effort to describe the fish community inside a CDF and a useful technique in evaluating aquatic areas in CDFs.

Additional Information

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Introduction

Several unsuccessful attempts have been made to sample fish in the open-water portion of Times Beach CDF, Buffalo, NY. The Corps of Engineers contracted with the National Fisheries Research Center—Great Lakes to determine if any fish inhabit the open water in the CDF and, if fish were found, to determine the condition of the population and compare it with fish populations in surrounding areas.

Diked Disposal Area 2, known locally as Times Beach, is an 18.4-ha alongshore CDF near the mouth of the Buffalo River (Figure 1). Being one of the earliest CDFs, Times Beach was constructed without a sheet liner or a dewatering system. During dredging operations, the water carrying the solids into the facility filtered through the dike walls until equilibrium was reached with the surrounding water of Lake Erie and the Buffalo River. The depth and volume of the open water continues to fluctuate with water levels in Lake Erie and the Buffalo River.

The facility, built in 1971 to receive dredged material from the Buffalo River and the adjacent outer harbor of Buffalo (Lake Erie), was filled to about half of its capacity by 1976. At that time, in response to a request by the Ornithological Society of Buffalo, the site was returned to the sponsor/owner, the City of Buffalo, to be used as a wildlife refuge. Although a diverse plant and animal community has developed, the real value of this site appears to be in its function as a bird sanctuary. More than 200 species of migratory and resident birds have been identified (Andrle 1986).

Three distinct ecological zones are in the Times Beach CDF (Figure 1). An upland zone, composing about a quarter of the total area, radiates from the discharge pipe. This zone is characterized by sandy soil and predominantly woody vegetation with an understory of scattered grasses and forbs. As the elevation decreases, the upland zone gives way to a transitional wetland that also accounts for about a quarter of the total area of the CDF. This zone, characterized by silty soils and populated with grasses, sedges, and rushes, is periodically inundated by water. The rest of the unit (8.1 ha) is open water with dense submerged aquatic vegetation and a maximum depth of about 2 m.

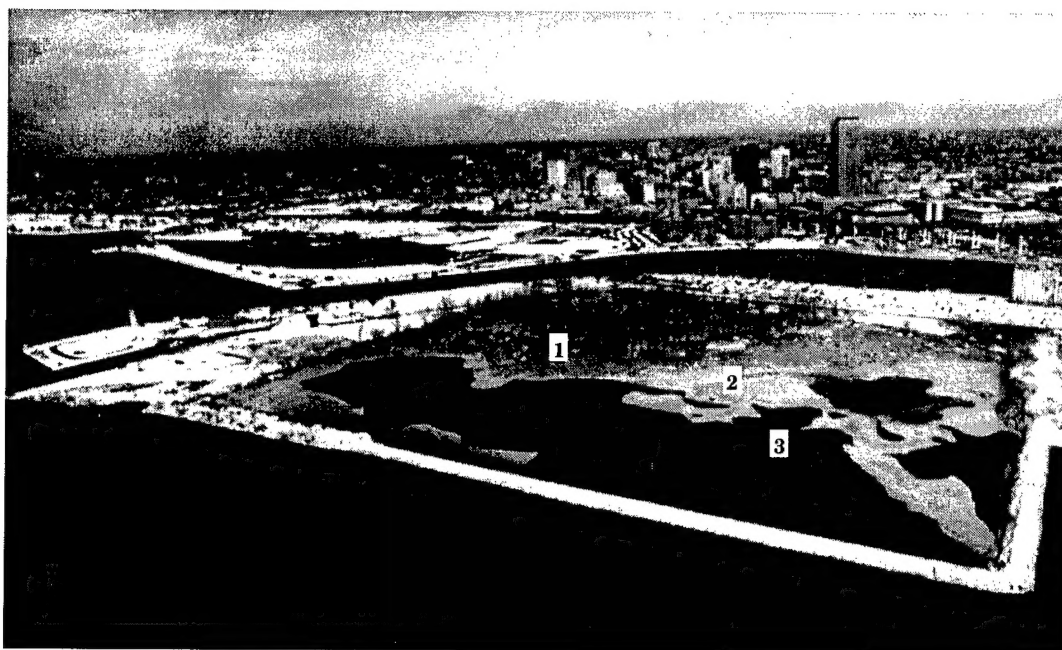


Figure 1. Aerial photograph of Times Beach CDF between the Buffalo River and Lake Erie, showing (1) upland, (2) wetland, and (3) aquatic zones

Methods

Fish were collected with hoop nets and by electrofishing on June 27-28 and October 17-18, 1988. The nets consisted of two hoop nets (1 m in diameter, made of 0.6-cm nylon delta mesh) connected to each other by a 1-m-high, 30-m-long lead (1.9-cm, square mesh). Five net sets (40 hr each) were made during the spring sampling. In the fall, low water limited the collections to only three net sets for 36 hr each. Pulsed direct current electrofishing was conducted from a boom electrofishing boat over the entire open-water area, where the water was deep enough to operate the boat. All stunned fish were collected and placed in a holding tank until they were measured, weighed, and examined, with the exception of large common carp which were counted in the water as they were stunned by the electroshocker but not retrieved. All other fish collected were measured to the nearest millimeter and examined for external abnormalities.

A large random subsample of fish was collected. These fishes were weighed and later aged from scale or spine samples. Selected fish were kept from both spring and fall collections for internal necropsy, and selected tissues were sampled for histopathological examination. On June 27-28, 1988, nearly all the fish, except some of the cyprinids, were fin-clipped for mark-recapture population studies.

Results and Discussion

The fish community inside the Times Beach CDF appeared to be more diverse in October 1988 than in July 1983, when qualitative studies with hook and line and periodic seining by Corps personnel yielded only four species (rock bass, common carp, pumpkinseed, and yellow perch) (Stafford and others 1991). Eighteen species of fish were collected from the Times Beach CDF. Pumpkinseed and rock bass were most frequently caught by both collection methods in both spring and fall.

Growth of several species was measured as length of fish according to age and indicated no substantial differences between the populations in the open-water portion of Times Beach CDF and other waters in the northeastern United States, similar to that observed in Lake Erie. The growth of golden shiners and largemouth bass was similar in Times Beach and in the inland lakes of New York, Michigan, and Ohio. Growth increments for rock bass (less than age 4), young brown bullheads, and pumpkinseed were slightly less in Times Beach than in Lake Erie and the inland New York lakes. Growth was slightly greater for yellow perch and carp in Times Beach than in waters of inland New York.

The external abnormality rate of brown bullheads in Times Beach CDF (89 percent) was higher than that reported for contaminated sites in Lake Erie (74 percent for Cleveland Harbor and 53 percent for the Black River, Lorain, OH). Frequency of external abnormalities on brown bullheads at a comparatively "clean" site (Huron River, Ohio) was 15 percent, and the frequency was also much lower for stubbed barbels and skin discoloration. The most frequently observed abnormality in Times Beach and at other Lake Erie locations was stubbed barbels. Skin discoloration, the next most frequently observed abnormality in Times Beach, was slightly lower than that in the other Lake Erie locations.

All metals and polynuclear aromatic hydrocarbons (PAHs) in sediments were much higher in Times Beach CDF than in the Huron River, Ohio. Times Beach sediments from 1981, and from samples collected at identical locations in 1986 (Marquenie, Simmers, and Kay 1987), showed a wide range of contaminants. Comparisons were made for metals and PAHs in Times Beach CDF sediments and in sediments in Ashtabula Harbor, Cleveland Harbor, upstream Black River, and from the Huron Harbor, Ohio. Concentrations of copper (Cu), mercury (Hg), chromium (Cr), and benzo(a)pyrene in sediments were higher in Times Beach CDF than in the harbor areas at Ashtabula or Cleveland or in the Black River.

Heavy metals were elevated in some components of the Times Beach fishery and, in some instances, exceeded action levels established by Australia (similar to those of the U.S. Food and Drug Administration, FDA) (Lee and others 1991). While the FDA has not established action levels for these metals to date, there should be reason for concern when tissue levels approach or exceed action levels that other countries consider to present a risk to the human population. Rock bass muscle tissue exceeded the FDA-like

action levels of 1.5 $\mu\text{g/g}$ lead (Pb) and 0.5 $\mu\text{g/g}$ Hg (wet weight basis), while liver tissue exceeded the levels of 1.0 $\mu\text{g/g}$ arsenic (As), 0.2 $\mu\text{g/g}$ cadmium (Cd), 10.0 $\mu\text{g/g}$ Cu, and 0.5 $\mu\text{g/g}$ Hg (wet weight basis). Carp liver tissues contained elevated levels of As, Cd, Cu, and Pb. The muscle tissue of goldfish exceeded the FDA-like action levels for Pb, and the liver tissue exceeded those for As, Cd, Cu, and Pb. Brown bullheads exceeded FDA-like action levels for muscle tissue Cd and live tissue As and Pb. Pumpkinseed exceeded the Australian FDA-like action levels for liver tissue As, Cd, Cu, Pb, and Hg. Organic contaminants were generally low and near the detection limits. Aquatic plant tissues contained low levels of heavy metals and, like the fish, only low levels of organic contaminants.

Conclusions

Despite high contaminant concentrations (mainly metals and PAHs) in the Times Beach sediments, fish appeared to be growing "normally." The extensive macrophyte beds contained large populations of aquatic insects. Although bioaccumulation of contaminants in fish has been observed, bioaccumulation and biomagnification of contaminants in waterfowl through the food web and the release and export of contaminants through insect emergence and migratory birds have not been examined but are potential concerns. Analysis of the primary and secondary trophic levels, as well as chemical analysis of each trophic level in the Times Beach CDF open-water pool, would give a better understanding of the potential bioaccumulation, biomagnification, and resulting bioavailability of the CDF contaminants. Because of public access to the CDF as a nature preserve, the effect of direct or indirect human contact with these contaminated sediments, macrophytes, invertebrates, or fish should also be addressed.

The results of this study indicated that contaminants in Times Beach sediments did not overtly affect the fish community. Population growth and condition of the fish were similar to those in a wide range of locations when evaluated in the same manner. However, the high incidence of minor external abnormalities and the observed bioaccumulation of certain metals in benthic fish species appear to indicate a potential for sediment-induced effects. Great Lakes CDFs that are in the process of being filled can have open-water pools for extended periods of time. The results of this study suggest that a study conducted at this level of detail, characterizing the fish communities in CDF open-water pools, can be an initial step to evaluate the potential for a contamination problem. This would be less expensive and less time consuming than comprehensive chemical residue analyses in the initial step of an evaluation. If a problem appears to exist, the more comprehensive chemical tissue analyses can be conducted on fish of concern selected from the community data collected initially.

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